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ABSTRACT

Five years of data related to teachers' perceptions of learning and knowledge were analyzed to ascertain whether differences existed between preservice elementary and secondary science students (N=435). These data were generated from a questionnaire derived from assumptions about learning and knowledge. The assumptions address five areas of learning: motivation; conditions of learning; social learning; intellectual development; and evaluation. Knowledge assumptions comprise a sixth area. The data were analyzed using a Chi Square statistic with the probability set at the .05 level of significance. Results indicate no significant differences in prescores for either elementary undergraduate and graduate students or secondary undergraduate students. No significant differences occurred with post scores between undergraduate and graduate elementary education students. However, significant differences occurred between undergraduate elementary and secondary students in the areas of assumptions about motivation, conditions of learning, and knowledge requirements of school children. These results support the National Science Teachers Association recommendations for the certification of elementary and middle/junior high school science teachers. Also, there is some indication that inservice and preservice education need to follow varying paths. (Author/JN)

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PRESERVICE SCIENCE EDUCATION - WHAT EFFECT METHODS CLASSES?

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INTRODUCTION

The effectiveness of science education in public schools seems to have decreased steadily over the past two decades. Mechling (1982), summarizing three National Science Foundation studies conducted during the 1970's, states science was deemphasized in schools, a significant number of teachers felt unqualified to teach science in the elementary schools and principals and state supervisors felt inadequate teaching preparation in science was a serious problem in their schools. The seriousness of the problem was also dramatized by a number of surveys which reported that little or no science was being taught in public elementary schools (Franz and Enochs, 1982; Gabel, 1981; Bethel, 1982).

Science teacher education rightfully shoulders a responsibility for the decrease of science education in elementary schools. According to Donnell (cited in NSTA, 1982), "Poor preservice teacher preparation is often cited as a prime contribution to the problem of science education at the elementary school level." Elementary teachers seem to have poor science content backgrounds as well as a lack of understanding in applying methodologies which foster the development of scientific thought (Bjorkquist, 1981; Ukens, 1983).

Science education in the middle/junior high school has also deteriorated in the past decade. Teaching fifth through eighth grades requires special training in both content and methods. Often elementary or secondary trained teachers are required to teach science at this level. It is not without good cause that a number of recommendations have been made calling for separate middle/junior high school methods and content courses to be offered to preservice science teachers who will teach in the middle/junior high school (Mechling, 1982; Corbett, 1983).

On the secondary level, ninth through twelth grade, there is concern that science teachers are not as effective as they could be (Anderson, 1981; McKenna, 1983). A 1980 National Science Foundation report states that we have been doing an excellent job of preparing future scientists but are failing to provide an adequate background for our general population (Anderson, 1981; McKenna, 1983). A lack of exposure to the application of varied learning styles, methodologies and pedogogy by preservice secondary science teachers may stifle growth in science education. Biddle (1964 cited in Horak, 1980) states "prospective teachers cannot simply be exposed to some facts about

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individual differences, some theories on learning and child development" and sent into the classroom to try to apply these theories on their own. Educational institutions must provide more experience which applies theory of intellectual development.

There is sufficient support within the research literature to indicate a need for reevaluating science content preparation requirements as well. The "Recommended Standards for the Preparation and Certification of Teachers of Science at the Elementary and Middle/Junior High School Levels," NSTA (1983), call for extensive and relevant content preparation of teachers of elementary school age children as well as methodologies and professional support for varied learning styles and appreciation of science. At the elementary school level teachers are expected to teach science, yet are notoriously unprepared to do so (Phillips, 1983-4; Franz, 1982).

Recommendations for separate content and internship courses for the middle/junior high school levels are noted. Also, on the secondary level, data from surveys of teachers in the field suggest a greater need for more teacher content knowledge and methodological skills at the secondary science level (Rubba, 1982; Valtmer, 1982).

Student enrollment (school size) presents problems for science education at all levels of schooling. Rural school populations, well over one-third of the student population in the United States, have limited student enrollment. Teachers, through necessity, must frequently teach several science areas in both the junior and senior high schools. Although it does not offer the strongest content background, combining content requirements for preservice teachers within several content areas might be preferable for rural teachers as opposed to obtaining background content in a single area (Anderson, 1981).

Content background and methodology cannot be divorced in the description of science education. Studies of methodology focus on the mode of presentation. Inquiry based instruction has been touted as the best approach, particularly for elementary levels (Anderson, 1981). Unfortunately, for many teachers the first exposure to inquiry teaching comes in a methods course AFTER content courses in both high school and college. The stimulus to appreciate the application to methodology comes too late in the developing teacher's education. A change in how preservice teachers perceive science and science teaching may be a key to breaking this cycle.

Bjorkquist (1982) posits a student oriented approach may produce more flexible and more self-confident teachers. However, data concerning elementary teachers indicate that most teachers use a teacher-dominated-student-recitation approach (Sunal, 1982). This approach does not allow for flexibiliy within a learning environment and is in direct opposition to the adequate proof of the positive effect of allowing for varied learning styles in the classroom (Herron, 1981; Yearney, 1978). This is especially true at the secondary level, where teachers themselves voice a need to be receptive to individual student needs and abilties (Rubba, 1982). Anderson (1981) offers a definition of a good science teacher as one who successfully implements a VARIETY of teaching strategies. Students of teachers who use a variety of teaching strategies learn more (Anderson, 1981).

Good science teaching has also been associated with positive teacher attitudes toward science. Attitude is a key to both teacher and student

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success (Levin, 1983) and attitude toward science teaching can also be used as a predictor of preservice teacher performance (Tanvo, 1981).

PURPOSE

Barth (1972) spoke to the concerns of all educators in his book, Open Education and the American School. He made a number of assumptions about education which were drawn from research and professional intuition. Since 1972, Barth has been disheartened by what he sees happening to open education. Robert Mai (1978) responds to Barth's concerns by describing a perception of American education as a pattern of commitment to a body of theory, isolation of elements of the theory and then putting into practice innovations which have no sensible relationship to the original theory.

The application of theory in an unadulterated form is the responsibility of the science teacher educator. Inferior science education comes from the lack of understanding of how science and children work. There needs to be more than a technician's level of application of learning principles.

This study was designed to evaluate how student's perceptions about education may have changed during the time they were involved in science methods courses. The courses taught used a variety of techniques employing various learning theories. For example, Gagne and White's (1978) model for memory structures was used in the development of physical science concepts. Actual activities related to Piagetian tasks and levels of understanding were performed. Bruner's approach to discovery learning and Ausubel's work on advance organizers was addressed, especially in the development of reading in the science area.

The study takes into account the intended audiences for method courses, the time of year in which the courses were taken, and the framework within which the courses were presented. Knowledge of these factors may guide science teacher educators in the development of methods courses which balance content, methodology and varied learning styles for the most effective preservice science education.

DESCRIPTION

A questionnaire entitled "Where Do You Stand?" (Appendix A) was used to obtain students' perceptions of learning and knowledge. Students were asked to respond to the questionnaire before and upon completion of a science methods course. First seen at Syracuse University, the questionnaire was derived from Barth's (1972) assumptions about education. The questionnaire was modified to reflect gender equity. The assumptions about learning speak to five areas: (1) Motivation; (2) Conditions of Learning; (3) Social Learning; (4) Intellectual Development; and (5) Evaluation. Knowledge assumptions comprise a sixth area.

Three science methods courses were involved in this study, undergraduate elementary science education, graduate elementary science education and undergraduate secondary general science education. Undergraduate content preparation includes 16 quarter hours of science (biological, physical and

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earth sciences) for elementary students. No content prerequisites for graduate students are required. Undergraduate science content for secondary students includes 90 to 100 quarter hours in a major and 40 to 45 hours for a minor. No specific subject science methods courses are offered on campus. All secondary preservice teachers take the general methods. Class size ranges from 15 to 35 students, undergraduate elementary science being the largest enrollment.

The elementary education students take the methods course in what is called a paraprofessional block. This block includes science, social sciences and physical education methods as well as as an extensive field experience. These three "block" courses seem to have an analytical approach to teaching and require students to analyze how children see their worlds, their social relationships, and their physical development. Secondary students have a limited field experience either before or during the methods course. Graduate students are usually seasoned teachers or administrators.

Data were collected for five years (1978 - 1983) on all of the courses. The Chi Square statistic was used to compare pre and post scores for each item of the questionnaire which pertained to the course objectives. Comparisons were made as to when the courses were offered, and the type of course taken. Twelve out of 29 items from the questionnaire were consistent with stated course objectives, although all 29 items may have been addressed in some peripheral manner.

RESULTS

The CROSSTABS program of SPSS was used to analyze the data. The level of statistical significance was set at the .05 level of probability with the number of cases (n) being 435.

There were no significant differences in prescores for either elementary undergraduate and graduate students or secondary undergraduate students. No significant differences occurred with post scores between undergraduate and graduate elementary education students. However, significant differences occurred between undergraduate elementary and secondary students in the areas of assumptions about motivation, conditions of learning and knowledge requirements of school children.

Table 1 contains the actual raw scores for the, "Where Do you Stand?" questionnaire. Cell size in the Motivation and Intellectual Development categories were smaller than would have been preferred. In all cases, responses to the questionnaire were positive in nature. However, the secondary undergraduate students were less inclined to accept the assumptions as proposed by Barth.

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TABLE 1

Chi Square Analysis of Post Scores
(Elementary vs Secondary Preservice Teachers)

Category	Item #	Elementary number of cases agree	n/a	dis	total	Secondary number of cases agree	n/a	dis	total	Raw Chi Square	Significance level
Motivation	1. Children are innately curious and will explore their environment without adult intervention.	323	7	1	331	95	4	8	107	21.8	.001
	2. Exploratory behavior is self-perpetuating.	303	24	4	331	91	10	6	107	7.7	.021
Conditions of Learning	6. Play is not distinguished from work as the predominant mode of learning in early childhood.	285	26	20	331	76	17	14	107	12.7	.002
	7. Children have both the competence and the right to make significant decisions concerning their own learning.	268	34	29	331	56	21	30	107	36.9	.001
	8. Children will be likely to learn if they are given considerable choice in the selection of the materials they wish to work with and in the choice of questions they wish to pursue with respect to those materials.	300	22	9	331	85	12	10	107	11.5	.003
	9. Given the opportunity, children will choose to engage in activities which will be of high interest to them.	321	7	3	331	105	1	1	107	.6	.730
Social Learning	11. When two or more children are interested in exploring the same problem or the same materials, they will often choose to collaborate in some way.	276	47	8	331	78	19	10	107	11.2	.004
	12. When a child learns something which is important to him or her, he or she will wish to share it with others.	300	25	6	331	93	8	6	107	4.4	.112
Intellectual Development	14. Children learn and develop intellectually not only at their own rate but in their own style.	314	13	4	331	101	4	2	107	.3	.875
	17. Verbal abstractions should follow direct experience with objects and ideas, not precede them or substitute for them.	259	53	18	330	72	23	12	107	6.6	.037
Knowledge	26. Knowledge is a function of one's personal integration of experience and therefore does not fall into neatly separate categories or "disciplines."	303	19	6	328	92	14	1	107	6.4	.040
	28. Little or no knowledge exists which it is essential for everyone to acquire.	183	82	63	328	50	23	34	107	7.4	.015

Key: Agree = collapsed data of strongly agree and agree opinion
N/A = no opinion
Dis = collapsed data of strongly disagree and disagree opinion

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DISCUSSION AND IMPLICATIONS

The instrument used to measure perceptions, although generated from the open school concept, evaluates basic precepts of learning and knowledge as applied to all learning situations. The situations under which teachers must work vary greatly among grade levels. But an understanding and appreciation for how children learn should help teachers provide enriching environments for learners at any level.

Elementary school teachers are commonly thought of as being more receptive to children's needs than are secondary teachers who are popularly referred to as content oriented. This study reinforces the generalization. However, the data also indicate a tendency for secondary teachers to be receptive to children's learning needs since all scores were positive.

Although the study shows a difference in the way in which preservice teachers view Barth's assumptions about learning as influenced by a methods course (secondary teachers being less likely to accept the assumptions related to motivation, conditions of learning and knowledge), the positive reaction of the secondary people is encouraging. There is a definite indication that preservice secondary teachers are concerned with children as well as content.

Secondary education students seem to have less of an inclination to feel that children have the competence and right to make significant decisions about their learning than do elementary teachers (item #7, Appendix A). This might be expected as a pre-methods stance but is contrary to expectations of students who had just taken a methods course which is designed to foster the process of giving children choices. A possible explanation may be that students have an experience in the schools while taking the methods class and this experience influenced how the statement is viewed. When a preservice student observes a "successful" teacher who does not offer choices, the preservice student begins to doubt the need for choice.

Another statement which seems to have shown fundamental differences between elementary and secondary preservice teachers was that little or no knowledge exists which is essential for everyone to acquire (item #28, Appendix A). Secondary students are in less agreement to the statement than are elementry students. This can be expected because of the emphasis placed on the development of fundamental concepts, especially science concepts which give the whole of science meaning. The view of concepts as knowledge may have been the students' interpretation.

Effective preservice should not be divorced from inservice, especially with the emphasis being placed on early field experience for teachers. The influence which practicing classroom teachers have on preservice teachers is great. A concerted effort should be made to have greater cohesion between the training of preservice and inservice teachers. As the fundamental structure of methods courses is changed, the rationale for change must be grounded in the evaluation of as much data related to the effectiveness of the courses as possible.

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BIBLIOGRAPHY

Anderson, H. One step at a time, but please hurry. Association for the Education of Teachers of Science. ERIC Document 214 759. December, 1981, 123-150.

Barth, R.S. Open Education and the American School. New York: Agathon Press, Inc., 1972.

Bethel, L. Tailoring inservice in science to elementary teachers needs. Phi Delta Kappan. February, 1982, 63, #6, 416.

Bjorkquist, O. Preservice teacher education in elementary science. ERIC Document 219 226. 1981.

Corbett, L. Preparation programs and certification standards for teachers of science and mathematics in the SREB region. ERIC Document 228 048. 1983.

Franz, J. and L. Enochs. Elementary school science; state certification requirements in science and their implications. Science Education. April, 1982, 66. #1, 287-92.

Gabel, D. and R. Sherwood. High school science courses do make a difference. School Science and Mathematics. 1981, 81, #6, 502-6.

Gagne, R.M. and R. T. White. Memory structures and learning outcomes. Review of Educational Research, 1978, 48, #2, 187-222.

Herron, D.J. Why aren't we doing it? Association for the Education of Teachers in Science. ERIC Document 214 759. December, 1981, 107-22.

Horak, W.J. An analysis and comparison of elementary preservice and inservice teachers' beliefs about science teachers classroom behaviors. ERIC Document 184 889. April, 1980.

Levin, J. Elementary teacher attitudes toward science in four areas relating to gender differences in students' science performance. ERIC Document 229 230. April, 1983.

Mai, R.P. Open education: from ideology to orthodoxy. Peabody Journal of Education. April, 1978, 231-237.

McKenna, Leonard N. Relationship between cognition of teaching and quality of teacher style in elementary science. ERIC Document 236 055. May, 1983.

Mechling, K. Survey results: preparation of teachers of science at the elementary, middle and junior high school levels. ERIC Document 214 804. March 1, 1982.

NSTA (Steering Committee on Teacher Education). ERIC Document 213 357. April, 1982.

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NSTA Position Statement, Recommended standards for the preparation and certification of teachers of science at the elementary and middle/junior high school levels. Science and Children. 1983, 21, #1, 65-70.

Phillips, D.B. Comprehensive science education program for preparing elementary school teachers. Journal of College Science Teaching. December-January, 1983-4, 13, #3, 156-9.

Rubba, P. Do physics teachers have special inservice needs? School Science and Mathematics. April, 1981, 291-4.

Sunal, D. Affective predictors of preservice science teaching behavior. Journal of Research in Science Teaching. February, 1982, 19, #2, 167-75.

Tanvo, D. Attitude scores as determinants of practice teaching performances of preservice undergraduate science teachers. Science Education. October, 1981, 65, #5, 485-92.

Ukens, L. Does science teacher preparation nurture effective science teaching? National Science Teachers Association Yearbook, ERIC Document 242 522. 1983, 60-62.

Valtmer, R. and R. James. Laboratory teaching competencies for science teachers as viewed by science education. School Science and Mathematics, 1982, 82, #3, 225-9.

Yearny, R. Effects of microteaching with videotaping and strategy analysis of preservice science teachers. Science Education. 1978, 62, #2, 203-7.

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Appendix A

WHERE DO YOU STAND?

(INSTRUCTIONS: Indicate by number which answer best corresponds to your own feelings about each statement)

1) Strongly agree
2) Agree
3) No strong feeling
4) Disagree
5) Strongly disagree

I. ASSUMPTIONS ABOUT CHILDREN'S LEARNING

1: Children are innately curious and will explore their environment without adult intervention. ____

2: Exploratory behavior is self-perpetuating. ____

3: The child will display natural exploratory behavior if he or she is not threatened. ____

4: Confidence in self is highly related to capacity for learning and for making important choices affecting one's learning. ____

5: Active exploration in a rich environment, offering a wide array of manipulative materials, will facilitate children's learning. ____

6: Play is not distinguished from work as the predominant mode of learning in early childhood. ____

7: Children have both the competence and the right to make significant decisions concerning their own learning. ____

8: Children will be likely to learn if they are given considerable choice in the selection of the materials they wish to work with and in the choice of questions they wish to pursue with respect to those materials. ____

9: Given the opportunity, children will choose to engage in activities which will be of high interest to them. ____

10: If a child is fully involved in and is having fun with an activity, learning is taking place. ____

11: When two or more children are interested in exploring the same problem or the same materials, they will often choose to collaborate in some way. ____

12: When a child learns something which is important to him or her, he or she will wish to share it with others. ____

13: Concept formation proceeds very slowly. ____

14: Children learn and develop intellectually not only at their own rate but in their own style. ____

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15: Children pass through similar stages of intellectual development each in his or her own way and at his or her own rate and in his or her own time. ____

16: Intellectual growth and development take place through a sequence of concrete experiences followed by abstractions. ____

17: Verbal abstractions should follow direct experience with objects and ideas, not precede them or substitute for them. ____

18: The preferred source of verification for a child's solution to a problem comes through the materials with which he or she is working. ____

19: Errors are necessarily a part of the learning process; they are to be expected and even desired, for they contain information essential for further learning. ____

20: Those qualities of a person's learning which can be carefully measured are not necessarily the most important. ____

21: Objective measures of performance may have a negative effect upon learning. ____

22: Evidence of learning is best assessed intuitively, by direct observation. ____

23: The best way of evaluating the effect of the school experience on the child is to observe him or her over a long period of time. ____

24: The best measure of a child's work is that child's work. ____

III. ASSUMPTIONS ABOUT KNOWLEDGE

25: The quality of being is more important than the quality of knowing; knowledge is a means of education, not its end. The final test of education is what a person <u>is</u>, not what he or she <u>knows</u>. ____

26: Knowledge is a function of one's personal integration of experience and therefore does not fall into neatly separate categories or "disciplines." ____

27: The structure of knowledge is personal and idiosyncratic; it is a function of a synthesis of each individual's experience with the world. ____

28: Little or no knowledge exists which it is essential for everyone to acquire. ____

29: It is possible, even likely, that an individual may learn and possess knowledge of a phenomenon and yet be unable to display it publicly. Knowledge resides with the knower, not in its public expression. ____

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For the author's full-length treatment of the above thesis, see Roland S. Barth, <u>Open Education and the American School</u> (New York, Agathon Press, 1972.)